

A review of *Typhisopsis* Jousseaume, 1880, and *Typhisala* Jousseaume, 1881 (Gastropoda: Muricoidea) of the eastern Pacific

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ABSTRACT

Typhisopsis Jousseaume, 1880, and *Typhisala* Jousseaume, 1881, are redescribed and the included species reviewed. *Typhisopsis coronatus* (Broderip, 1833) is considered as the senior synonym of *T. quadratus* (Hinds, 1843), *Murex siphoniferus* Lesson, 1844, and *Typhis martyria* Dall, 1902. In addition, *Typhisopsis carolskoglundae* new species is described from western Panama. Its range extends to Sonora, Mexico. The new species is compared with *Typhisopsis coronatus*, *Typhisala grandis* (A. Adams, 1855) and *T. clarki* (Keen and Campbell, 1964).

The four species have different shell morphology, especially in the number, height, and breadth of the spiral cords, the morphology of the axial ribs and the siphonal canal. The protoconchs of the four species are illustrated for the first time. Lectotypes are designated for *Murex siphoniferus* and for *Typhisala grandis*.

INTRODUCTION

A few months ago, the senior author received a lot of specimens of “*Typhis*” species from Costa Rica for identification. At first sight that lot was separated into two species: *Typhisopsis coronatus* and *Typhisala grandis*. However, after more careful examination and discussion, we began a complete re-evaluation of the whole group occurring in the eastern Pacific. *Typhisopsis coronatus* was described from a sub-adult specimen. Another species, previously identified as a dwarf form of *Typhisala grandis* by D’Attilio (1987) and D’Attilio and Hertz (1988) was re-examined. It is here described as a new species of *Typhisopsis*.

Keen (1944), Gertman (1969), Radwin and D’Attilio (1976), Vokes (1988), and other authors classified all the *Typhis*-like species in the Muricidae, subfamily Typhinae

Cossmann, 1903. D’Attilio and Hertz (1988) included the species related to *Typhis* in the family Typhidae [as in Sacco (1904) and Garrard (1963)] and split it into two subfamilies: Typhinae and Tripterotyphinae. D’Attilio and Hertz, 1988. Their study was based on morphological differences of shell and radular structure. The validity of Tripterotyphinae is not questioned herein. Subsequent authors, however, chose to retain Tripterotyphinae, as well as Typhinae, as a subfamily of Muricidae instead of Typhidae (Vokes, 1989a, 1989b, 1996; Houart, 1991, 1994, 2002; Absalão and Santos, 2003). DNA work currently under way elsewhere (Oliverio and Houart, in prep.) for *Typhinellus labiatus* (Cristofori and Jan, 1832) (= *Typhis sowerbyi* H. and A. Adams, 1855) as well as future DNA work may help clarify the taxonomy in this group. Radular terminology follows Houart (1991) based on D’Attilio and Hertz (1988).

Abbreviations used in this study are: BM(NH): Natural History Museum, London, Great Britain; CAS: California Academy of Sciences, San Francisco, California, USA; IRSNB: Institut royal des Sciences naturelles de Belgique, Bruxelles, Belgium; LACM: Natural History Museum of Los Angeles County, California, USA; MNHN: Muséum national d’Histoire naturelle, Paris, France; MZCR: Museo de Zoología, San José, Costa Rica; SBMNH: Santa Barbara Museum of Natural History, California, USA; SDNHM: San Diego Natural History Museum, California, USA; SUPTC: Stanford University Paleontological Type Collection, Stanford, USA; USNM: National Museum of Natural History, Washington, D.C., USA; CJH: Carole and Jules Hertz Collection, San Diego, California, USA; CS: Carol Skoglund Collection, Phoenix, Arizona, USA; RH: Roland Houart Collection, Landen, Belgium; RZ: Ricky Zaidali Collection, Abaco, Bahamas; spec.: live-taken specimen; del spec.: empty shells, dead collected.

SYSTEMATICS

Subfamily Typhinae Cossmann, 1903

Description: Shells with aperture entire, usually with projecting peristome and no sulcus; usually four or more

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varices per whorl, either wing-like or with axial swellings; rounded, ventrally sealed anal tubes originating from apical spiral cord, only current anal tube functional, older tubes sealed; siphonal canal ventrally sealed with left side overlapping right side.

Genus *Typhisopsis* Jousseaume, 1880

Type Species: *Typhis coronatus* Broderip, 1833, eastern Pacific, by original designation.

Description: Shell with four varices; apertural varix of adult with varical flange, frilled abaperturally. Varices heavy, rounded, rope-like. Shoulder spines broad-based, triangular, flat, tapering inwards to a sharp point. Partition connecting apertural shoulder spine and last teleoconch whorl. Anal tubes situated near preceding varix. Siphonal canal broad, ventrally sealed. Left side of canal broadly overlapping right side.

Typhisopsis coronatus (Broderip, 1833)
(Figures 1–15, 16, 44–46, 56–57, 61–62, 67)

Typhis coronatus Broderip, 1833: 178; Sowerby, 1841, pl. 200, figs 3,4.

Typhis quadratus Hinds, 1843: 18; Hinds, 1844: 10, pl.3, figs 3, 4.

Murex siphoniferus Lesson, 1844: 165.

Typhis martyria Dall, 1902: 550; Dall, 1908, pl.15, fig.11.

Typhis (Typhisopsis) coronatus.—Keen, 1944: fig. 17; Keen, 1971: 540, fig. 1051 right [type figure of *T. quadratus*]; Abbott, 1974: 192 (2017).

Typhisopsis coronatus.—D'Attilio, 1975: 57, text fig.; D'Attilio, 1976: 25, text figs; Radwin and D'Attilio, 1976: 212, pl. 32, figs. 10–12; Abbott and Dance, 1982: 157, text fig.;

D'Attilio, 1987: 34–35, figs 7–11; D'Attilio and Hertz, 1988: 21, fig. 109.

Typhis coronatus.—Kaicher, 1978: card 1595.

Typhis (Typhisopsis) grandis.—Keen, 1971, 540, fig. 1052 [not *Typhisala grandis* (A. Adams, 1855)].

Not *Typhis (Typhisopsis) coronatus*.—Keen, 1971: 540, fig. 1051 (left) not Broderip, 1833 [= *Typhisala grandis* (A. Adams, 1855)].

Description: Shell up to 40 mm in length. Biconic, heavy; spire high, acute; protoconch off-white, of 2.75 rounded whorls, first protoconch whorl pustulose, remaining whorls smooth; terminal lip thin, raised, curved (Figures 44–46). First four teleoconch whorls smooth, glossy, with no microsculpture; intritacalx covering penultimate and final whorl with microsculpture consisting of regular gouge-like pits (Figure 57). Shell with six weakly shouldered, nodose teleoconch whorls. Last whorl broad; suture moderately impressed and mostly obscured. Axial sculpture of four broad, rounded, rope-like varices, each bearing a broad, flat, triangular, strongly inward-bent, shoulder spine at intersection with P2. On last whorl apertural varix broadly expanded, edge reflected dorsally, frilled abaperturally with posterior edge extending into a sharp, dorsally incurved spine at shoulder; anal siphon (tube) adjacent to preceding varix and appressed to partition connecting the varix of previous whorl. Final anal siphon long and dorsally directed.

Spiral sculpture on three earliest varices of heavy raised spiral cords (P3–P6) becoming less prominent at the anterior end, intervarical spiral sculpture faint or absent. Siphonal canal long, broad (Table 1), ventrally

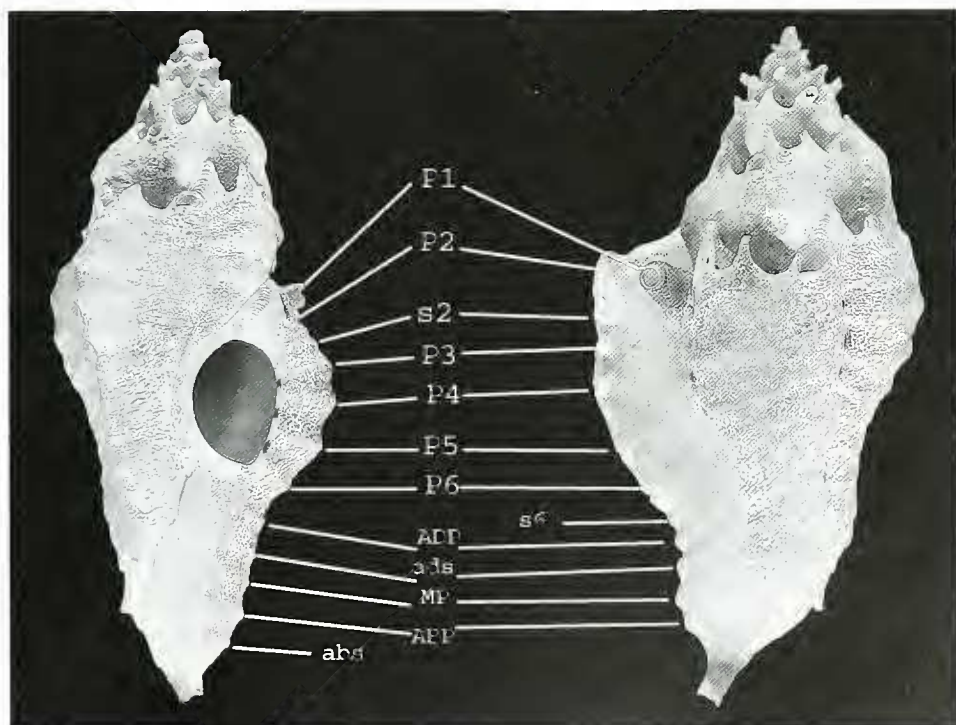


Figure 1. Morphology of the spiral cords in *Typhisopsis coronatus* (Broderip, 1833).

Table 1. Terminology used to describe the spiral cords (based on Merle 1999, 2001)

P	Primary cord
s	Secondary cord
P1	Shoulder cord
P2–P6	Primary cords on the convex part of the teleoconch whorl
s1–s6	Secondary cords on the convex part of the teleoconch whorl
Example: s1 = secondary cord between P1 and P2; s2 = secondary cord between P2 and P3, etc.	
ADP	adapertural primary cord on the siphonal canal
MP	median primary cord on the siphonal canal
ABP	abapertural primary cord on the siphonal canal
ads	adapertural secondary cord on the siphonal canal
ms	median secondary cord on the siphonal canal
abs	abapertural secondary cord on the siphonal canal

sealed along its length with 5 cords (probably ADP, ads, MP, ABP, abs), tapering with long, backwards facing, sealed tube at distal end. Suture line strongly shifted to the right. Aperture white, moderately large, smooth, sub-circular, entire, forming an erect peristome appressed posteriorly. Intra-axial chalky, off-white, deeply and irregularly pitted. Shell color white to cream with brown suffusions on varices, tips of shoulder spines, and tip of siphonal canal; two to five brown spots on edge of apertural lip, sometimes none, on occasional specimens these spots also on leading side of varices. Operculum corneous, light brown with 13–15 concentric lamellae and terminal nucleus. Radula (Figure 67) with rachidian tooth bearing a long central cusp, and on each side 3 or 4 slightly shorter, narrower lateral denticles of varied strength and length or erratically fused, and a broad lateral cusp, slightly shorter than central cusp. Lateral teeth sickle shaped, broad.

Type Material: *Typhis coronatus*: Ecuador, Salango, holotype BM(NH) 1966-447; *Typhis quadratus*: Costa Rica, Golfo de Nicoya, and Ecuador, Bahía de Guayaquil, dredged from a muddy bottom 7 to 18 fms (13–33 m) (Golfo de Nicoya is here designated as type locality), holotype BM(NH) 1844.6.7.35; *Murex siphoniferus*: Mexico, Acapulco, Guerrero, 1 lectotype MNHN (here selected); *Typhis martyria*: Golfo de California, off San Pedro Martír, 26 m, sand, holotype USNM 130629.

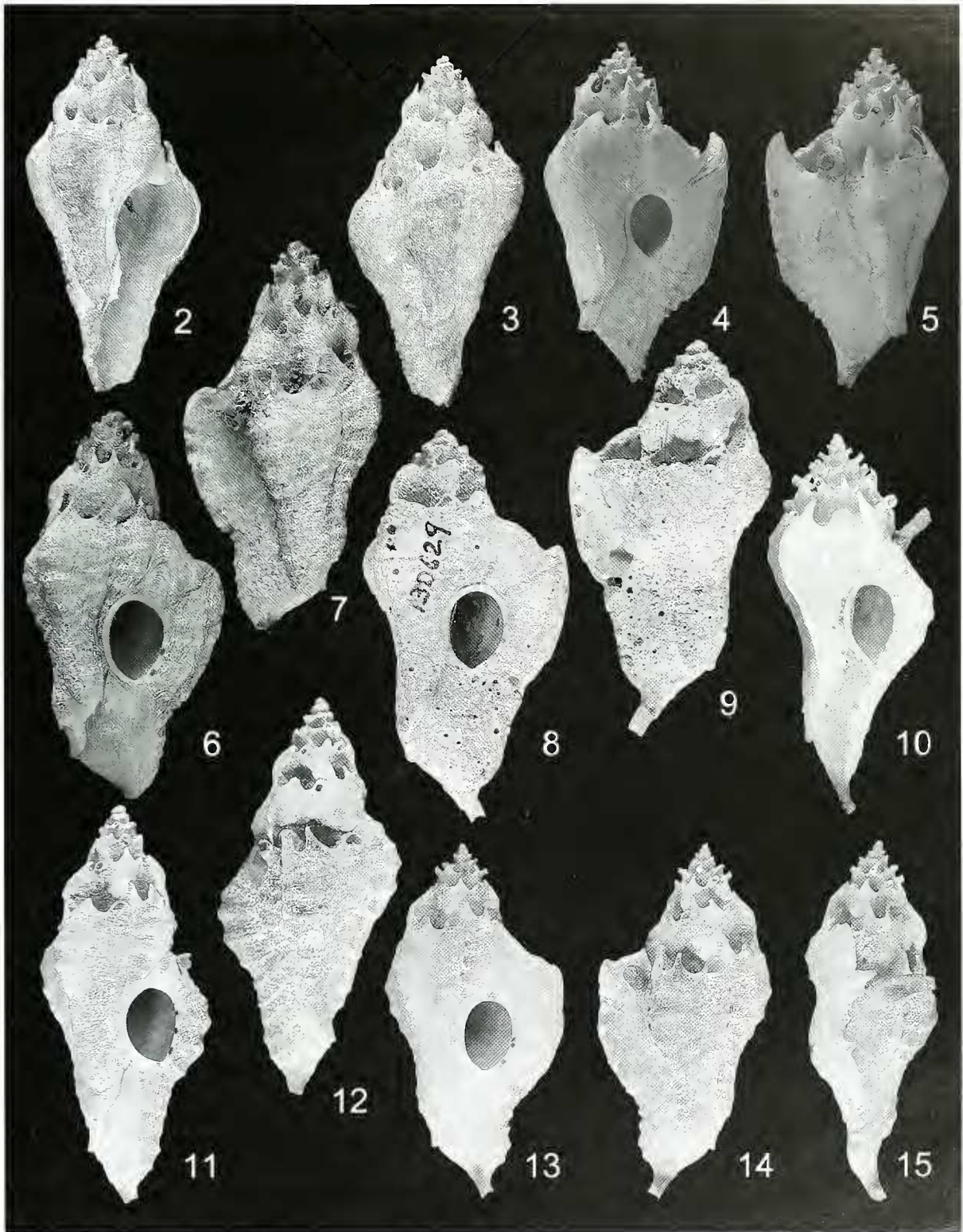
Other Material Examined: Mexico, Bahía Magdalena, Baja California Sur, 1 spec. (SBMNH); San Felipe, Baja California, 1 spec. (SBMNH); Bahía de los Angeles, Baja California, dredged 27 m, 1 spec. (SDNHM 23216 [figured in Radwin and D’Attilio, 1976]); off Isla San Marcos, Baja California Sur, divers, 12 m on *Spondylus princeps*, 1 spec. (CS); Isla Carmen, Baja California, 1 dd spec. (SDNHM); Isla Danzante, Baja California Sur, dredged 35–40 m, 3 spec. (CS); dredged 30–45 m, 3 spec. (CJH); Bahía Concepción, Baja California, 1 spec. (SDNHM); Cabo Tepoca, Sonora, dredged 20–30 m,

sand bottom with rocks, 5 spec. (CS); Guaymas, Sonora, dredged, 24 m, 1 spec., (RH); 1 spec. dredged (SDNHM 43812); 55 m 1 dd spec. (MNHN); Bahía Bacolubampo, Sonora, dredged 42 m, 1 spec. (MNHN); dredged 18–27 m, 2 spec. (CJH); 150 spec. (SBMNH); Sonora 1 spec. (MNHN), 2 spec. (RH); off Bahía San Carlos, Sonora, 19–38 m, 1 spec. (IRSNB IG 26.158); dredged 18–22 m, 98 spec. (CJH); dredged 15–30 m, 14 spec. (CS); 4 spec., 31 m (SDNHM 90837); dredged 100 m, 3 spec. (SDNHM 71920); off Tetas de Cabras, dredged 60–100 m, 7 spec. (SDNHM 92766); Tenacatita, Jalisco, 2 spec. (SBMNH); Manzanillo, Colima, near harbor entrance, 15–22 m, 1 spec. (RH); dredged 10–30 m, 3 spec. (CS); dredged 31 m, 4 spec. (SDNHM); dredged 100 m, 3 spec. (SDNHM); dredged 60–100 m, 7 spec. (SDNHM); 16 spec. (SBMNH); Salina Cruz, Oaxaca, 5 spec. (SBMNH); Costa Rica, Playas del Coco, Guana-caste dredged 24 m, 4 spec. (CS); dredged 24–36 m, 4 spec. (CJH); dredged 24–36 m, 2 spec. (SDNHM 90774); 1 dd spec. (SDNHM 91506); 1 spec. (SBMNH); 16 spec. (SBMNH); Panama, 21 spec. (SBMNH); Isla Santa Catalina, dredged 5–8 m, 5 spec. (RH); Boca de la Honda, 7°27’N, 80°51’W, in white sand, 2 spec. (RH); SE Isla Rancheria, Golfo de Chiriquí, dredged 15–30 m, 1 spec. (SDNHM 90775); Isla Cébaco, off Golfo de Montijo, Veraguas, in silty sand and rubble, 6–9 m, 1 spec. (MNHN); Bahía Montijo, Veraguas, 19 m, 1 spec. (RH); Arenas de Quebro, dredged 19–38 m, 1 spec. (RH); Isla Venado, 1 dd spec. (SDNHM 64236); Ecuador, Islas Galápagos, Isla San Salvador, close to Bahía James, 30–35 m, coll. D.R. Shasky, 1 spec. (SBMNH 366002).

Distribution: San Felipe, Baja California and Cabo Tepoca, Sonora, Mexico, to Guayaquil, Ecuador and Islas Galápagos, 5–42 m.

Remarks: Subadult specimens of *T. coronatus* (Figures 11–12, 62), as in the type, have an incompletely formed apertural lip which gives the shell a narrower and more slender outline. The first four teleoconch whorls (to a length of approximately 15 mm) of *T. coronatus* are smooth and shiny without the microsculpture evident on mature shells. In juvenile specimens the siphonal canal is also narrower, having a more centrally situated suture line.

Of the two syntypes of *Murex siphoniferus* (MNHN), one is *Typhisala grandis*, the other is conspecific with *Typhisopsis coronatus*. As first revisers, and in order to maintain the name *T. grandis* as it was illustrated by recent authors, we designate that latter specimen of *Murex siphoniferus* as lectotype (Figures 6–7). Two of the three syntypes of *Typhisala grandis* (A. Adams, 1855) are specimens of *Typhisopsis coronatus* (see under that species for further explanation). The holotype of *T. quadratus* (BM(NH)) has the siphonal canal broken, but the overall shape of the shell is quite the same as the intact specimen illustrated by Hinds (1844: pl. 3, figs 3–4). No other specimen was located in the type material.



Figures 2–15. *Typhisopsis coronatus* (Broderip, 1833). 2–3. Ecuador, Salango, holotype BM(NH) 1966447, 26 mm (photo P. Crab, BMNH). 4–5. *Typhis quadratus* Hinds, 1843. Costa Rica, Golfo de Nicoya (herein designated as type locality), holotype BM(NH) 1844.6.7.35, 17.5 mm (photo P. Crab, BMNH). 6–7. *Murex siphoniferus* Lesson, 1841. Mexico, Acapulco, Guerrero, lectotype MNHN (here designated), 27.9 mm (photo D. Brabant, MNHN). 8–9. *Typhis martyria* Dall, 1902, holotype USNM 130629. Golfo de California, off San Pedro Martir, 27.6 mm. 10. *Typhisopsis coronatus*. Tetas de Cabra, Guaymas, Sonora, Mexico, 19.4 mm. CJH (photo P. Sadeghian) (protoconch illustrated Figures 43–45). 11–12. Panama. Santa Catalina, 5–8 m, RH, 26 mm. 13–15. West Panama. Boca de la Honda, 7°27' N, 80°51' W, in white sand, RH, 23.56 mm.

Typhisopsis carolskoglundae new species
(Figures 17–25, 47–49, 59, 63)

Typhisala grandis.—D'Attilio, 1987: 32, figs. 1–6; D'Attilio and Hertz, 1988: 72–73, figs. 108 a–e [not *Typhisala grandis* (A. Adams, 1855)].

Description: Shell up to 30.9 mm in length, slender, heavy. Spire high, 40–48% of total shell length. Protoconch off-white, conical with 2.7 rounded protoconch whorls, first whorl pustulose, remaining whorls smooth, ending with delicate, thin, weakly erect and curved terminal lip; (Figures 47–49); teleoconch with up to 5 or 6 broad, strongly shouldered whorls. Suture impressed, partly obscured; axial sculpture of first three teleoconch whorls with sharp varices; remaining teleoconch whorls consisting of four strong, broad, rounded varices with remains of sharp lamina visible on varices of last whorl; each varix with a broad, flat, long, strongly inwards pointed triangular, flat spine at adapical extremity touching previous whorl. Anal tube adjacent to leading edge of varix and appressed to previous partition. Varices broader and swollen at shoulder periphery. Apertural varix with a moderately broad, recurved, sinuous flange, a slightly broad, long, somewhat curved spine at posterior edge, spine attached to previous whorl by an axially grooved partition densely sculptured spirally; lip edge roundly curving into siphonal canal approximately 1/4 from the end.

Apertural varix with strong spiral cords beginning at its outer lip and over-riden by strong axial limbration; outer recurved edge of abapertural side squamose. Spiral sculpture of raised, heavy, primary cords on varices. Last whorl with 15 cords (P1, P2, s2, P3, s3, P4, s4, P5, s5, P6, followed by rounded cords on siphonal canal, probably ADP, ads, MP, ms and ABP), forming a broad expansion at adapical extremity of apertural varix. P1 with sealed, rounded anal tube near preceding varix. P2 with flat, triangular spine at intersection with varices. Intervarical sculpture faint or absent under magnification (20×). Sealed rounded anal tube appressed to partition on preceding varix, forming an angle of approximately 80–90° with axis of shell. Spiral cords ending as short, strongly backward curved spines at edge of apertural varix.

Aperture subcircular, forming a continuous peristome, erect at outer lip and anterior portion of columellar lip and appressed posteriorly. Siphonal canal comparatively short, broad, ventrally sealed. Sutural line strongly shifted to the right, left side of canal broadly overlapping right side. Intact specimens ending with canal dorsally reflected and curved to the right at extremity.

Fresh, not overly cleaned specimens, with a simple, chalky off-white intritacalx showing occasional axial striae. Protoconch off-white with white pustules on first whorl. Teleoconch color white to cream with brown on shoulder spines and anal tubes; 2–5 brown spots on edge of outer apertural lip and often visible on leading edge of previous varices. One brown spot midway intervarically on each varix except the apertural varix, as in *Typhisala*

grandis. Operculum light brown with 12–14 concentric lamellae and terminal nucleus. Radula not examined.

Type Material: Holotype: SDNHM 90773, Costa Rica, Playas del Coco, Guanacaste, on mud bottom, 24–37 m; Paratypes: Costa Rica, Playas del Coco, Guanacaste, on mud bottom, 24–37 m, 1 paratype (SDNHM 93558); on mud bottom, 24–37 m, 1 paratype (CJH); dredged 12–25 m, 3 sp. (CS); 2 spec., 18–27 m in coarse sand, broken shell bottom (SBMNH 359431); 1 paratype (SBMNH 359436); 5 spec., 9–30 m (SBMNH 359435); 1 paratype (USNM 1084298); 1 paratype (LACM 3066); Isla Negritos, Golfo de Nicoya, 3 paratypes, 21–27 m, coarse sand, broken shell (SBMNH 359430); Panama, Arenas de Quebro, Veraguas, 19–37 m, 1 paratype (RH); Boca de la Honda, 7°27' N, 80°51' W, in white sand, 1 paratype (BM(NH) 20050371); 1 paratype (MZCR UCR 6153); 1 paratype (MNHN Moll 6991); 2 paratypes (RH); off Isla Gobernadora, intertidal, 1 paratype (RH); off Isla Venado, Bahía Panama in muddy sand at low tide, 1 paratype (IRSNB IC 26.817/566); Bahía Chiriquí, 74 m, 1 paratype (IRSNB IG 28.466/567); Contadora, Perlas Archipelago, Bahía de Panama, 4 paratypes, 15–30 m (SBMNH 359432); 1 paratype (SBMNH 359429); Ecuador, Isla Santiago, Islas Galápagos, 1 paratype (SBMNH 359433).

Other Material Examined: Mexico, Bahía San Carlos, Sonora, 31 m, 1 spec. (RH).

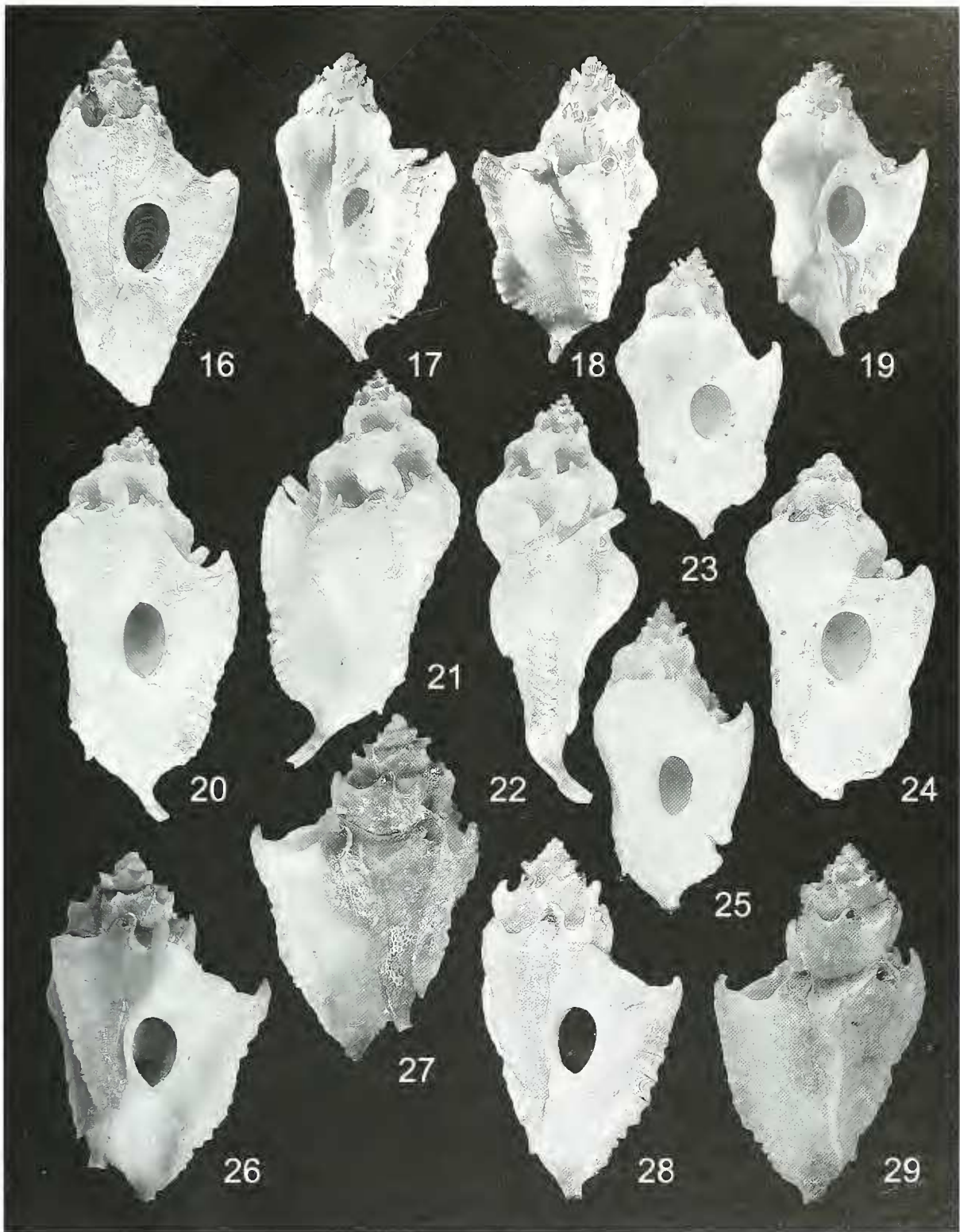
Type Locality: Costa Rica, Guanacaste, Playas del Coco, on mud bottom, 24–37 m.

Distribution: Sonora, Mexico to Isla Venado Bahía de Panama, Panama, from the intertidal to 74 m and Islas Galápagos, Ecuador.

Etymology: This species is named in honor of Carol Skoglund of Phoenix, Arizona, author and specialist in Panamic mollusks, who first collected the type material of this species and donated the holotype and a paratype to the SDNHM. She has also donated additional paratypes of this species from her private collection to the USNM and to the LACM.

Remarks: *Typhisopsis carolskoglundae* differs from *T. coronatus* in having a broader siphonal canal with an expanded varical flange, extending almost to the tip of the siphonal canal; flange sinuous midway to the anterior end, roundly curving into the siphonal canal, approximately 1/4 from the end and constricted at the base. It has a relatively smooth shell surface under a chalky, simple intritacalx, compared to the squamose, pitted intritacalx in *T. coronatus*. The axial ribs are usually broader at the shoulder, and there are more numerous and slightly narrower spiral cords on the last teleoconch whorl, 15 in contrast to 11–12 in *T. coronatus*. The varices appear broader in *coronatus* and the spiral cords are less pronounced in the new species.

The holotype of *Typhisopsis carolskoglundae* was il-



Figures 16–29. Species of *Typhisopsis* and *Typhisala*. **16.** *Typhisopsis coronatus* (Broderip, 1833), Mexico, Colima, Manzanillo, near harbor entrance, 15–22 m, coll. RII, 24.35 mm. **17–25.** *Typhisopsis carolskoglundae* new species **17–18.** Costa Rica, Playa del Coco, Guanacaste, on mud bottom, 24–37 m, holotype SDNHM 90773, 17.8 mm (photo K. Barwick) **19.** Paratype SDNHM 93555 17.1 mm (photo K. Barwick). **20–22.** Western Panama, Boca de la Honda, 7°27' N, 80°51' W, in white sand, paratype RII 30.1 mm. **23.** Western Panama, Boca de la Honda, 7°27' N, 80°51' W, in white sand, paratype MNHN Moll 6991, 18.9 mm. **24.** Mexico, Sonora, Bahía San Carlos, 31 m, RII, 26 mm. **25.** Paratype SBMNH 359436, type locality, 16.6 mm (photo P. Sadeghian) protoconch illustrated Figures 46–45). **26–29.** *Typhisala clarki* (Keen and Campbell, 1964). **26–27.** Bahía Panamá, Isla Venado, holotype CASIZ 064667 [ex-SUPTC 9724], 22.8 mm (photo G. Metz) **28–29.** Paratype BMNH, 22 mm (photo P. Crab, BMNH).

illustrated in D'Attilio (1987: figs. 1 and 2 [left]) and D'Attilio and Hertz (1988: fig. 10S, a–e), as a dwarf *Typhisala grandis*, but *Typhisopsis carolskoglundae* differs from *Typhisala grandis* in having a smaller, narrower shell at maturity and fewer and broader spiral cords on the last teleoconch whorl (15 in *Typhisopsis carolskoglundae* in contrast to 20–23 on *Typhisala grandis*). *Typhisopsis carolskoglundae* also has broader, shorter, flat varical shoulder spines, typical of *Typhisopsis* and narrower less sharp axial ribs with the flange on the apertural varix more strongly constricted at the base of the siphonal canal than in *Typhisala grandis*.

Typhisopsis carolskoglundae differs from *Typhisala clarki* in having broad, rounded varices, rather than the sharp varices in *T. clarki*, in having anal tubes adjacent to the leading edge of varices rather than midway between varices, and in having brown spots on the aperture edge and on previous varices, which are lacking in *Typhisala clarki*. The new species is similar to *grandis* and *clarki* in having an expanded, strongly fimbriate varical flange and a smooth shell under a simple chalky intritacalx.

Gems *Typhisala* Jousseau, 1881

Type species: *Typhis grandis* A. Adams, 1855, eastern Pacific, by original designation.

Description: Shell with four varices; apertural varix of adult with broad apertural varical flange extending to almost the tip of siphonal canal, fimbriate abaperturally; other varices sharp, narrow. Shoulder spines narrow; spines of three abapical teleoconch whorls narrow, twisted, curved inwards; partition connecting apertural spine and last teleoconch whorl. Anal tubes situated near preceding varix, pressed against preceding partition. Siphonal canal broad, ventrally sealed; left side of canal overlapping right side.

Typhisala clarki (Keen and Campbell, 1964)
(Figures 26–29, 30–34, 50–52, 5S, 64, 68)

Typhis (*Typhisopsis*) *clarki* Keen and Campbell, 1964: 4S, pl. 9, figs. 15, 19, 23.

Typhis (*Typhisopsis*) *clark*. —Keen, 1971: 540, fig. 1050; Abbott, 1974: 192 (2016).

Typhis clarki. —Gemmell, 1974: 100–103, 5 figs.; Kaicher, 1980: card 250S.

Typhisala clarki. —D'Attilio, 1975: 58, text fig.; Radwin and D'Attilio, 1976: 211, pl. 31, fig. 5; Gemmell and D'Attilio, 1979: 88–93, figs. 1–8; D'Attilio and Hertz, 1988: 20, fig. 107.

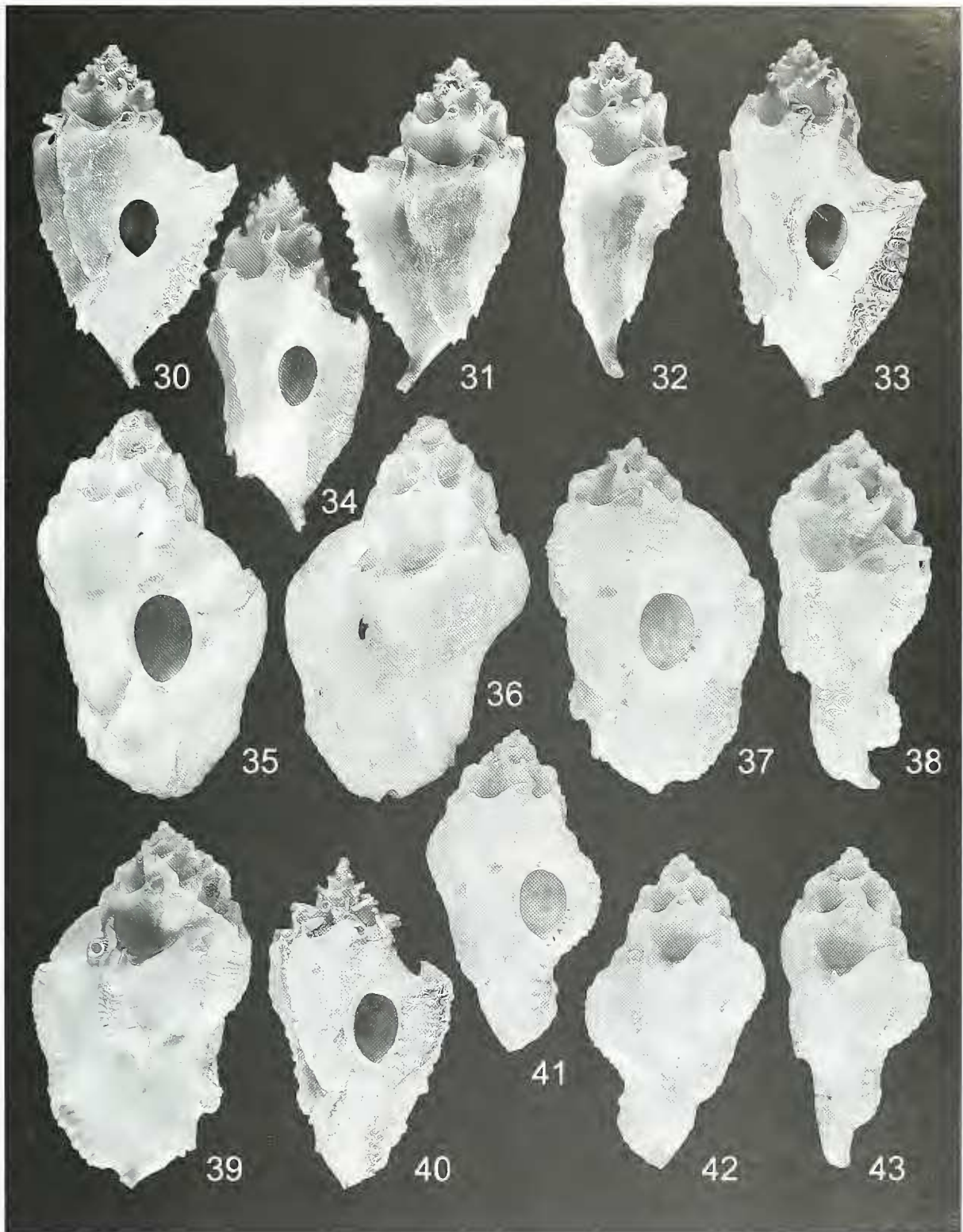
Description: Shell up to 27 mm in length, biconic, lamellate, delicate. Spire moderately high, 39–42% of total shell length; protoconch of 2.5 off-white, smooth, convex, conical whorls, first whorl pustulose, remaining whorls smooth (Figures 50–52); teleoconch with six angulate, strongly shouldered whorls. Suture impressed, partly obscured by succeeding whorl. Axial sculpture of

teleoconch consisting of four high, sharp, narrow, lamellate varices, each with a slightly open, long, twisted, inward curved spine adapically, each varix composed of two appressed laminae, one on the receding edge extending further than the one on leading edge, the two forming the slightly open spine at shoulder. Anal siphon (tube) forming an angle of approximately 85–90° with axis of shell, placed approximately midway between varices and appressed to previous partition, last tube only complete, long, open. Apertural varix flange-like, strongly fimbriate, dorsally reflected as shallow, open spinelets at outer edge. Apertural spine broad, triangular, weakly or strongly dorsally curved, connected to last teleoconch whorl by a broad, high, lamellate, partition. All other spiral cords ending as short, weakly or strongly backward curved, open spinelets at edge of apertural varix. Spiral sculpture faint, where present, 12–14 intervarical lines visible on some specimens under magnification (10×) corresponding to open spinelets at outer apertural edge. On fresh specimens, not over-cleaned, intritacalx sculpture of simple axial striae present. P1 with sealed, tapering, anal tube. P2 ornamented with long, upwards curved spine at intersection with varix.

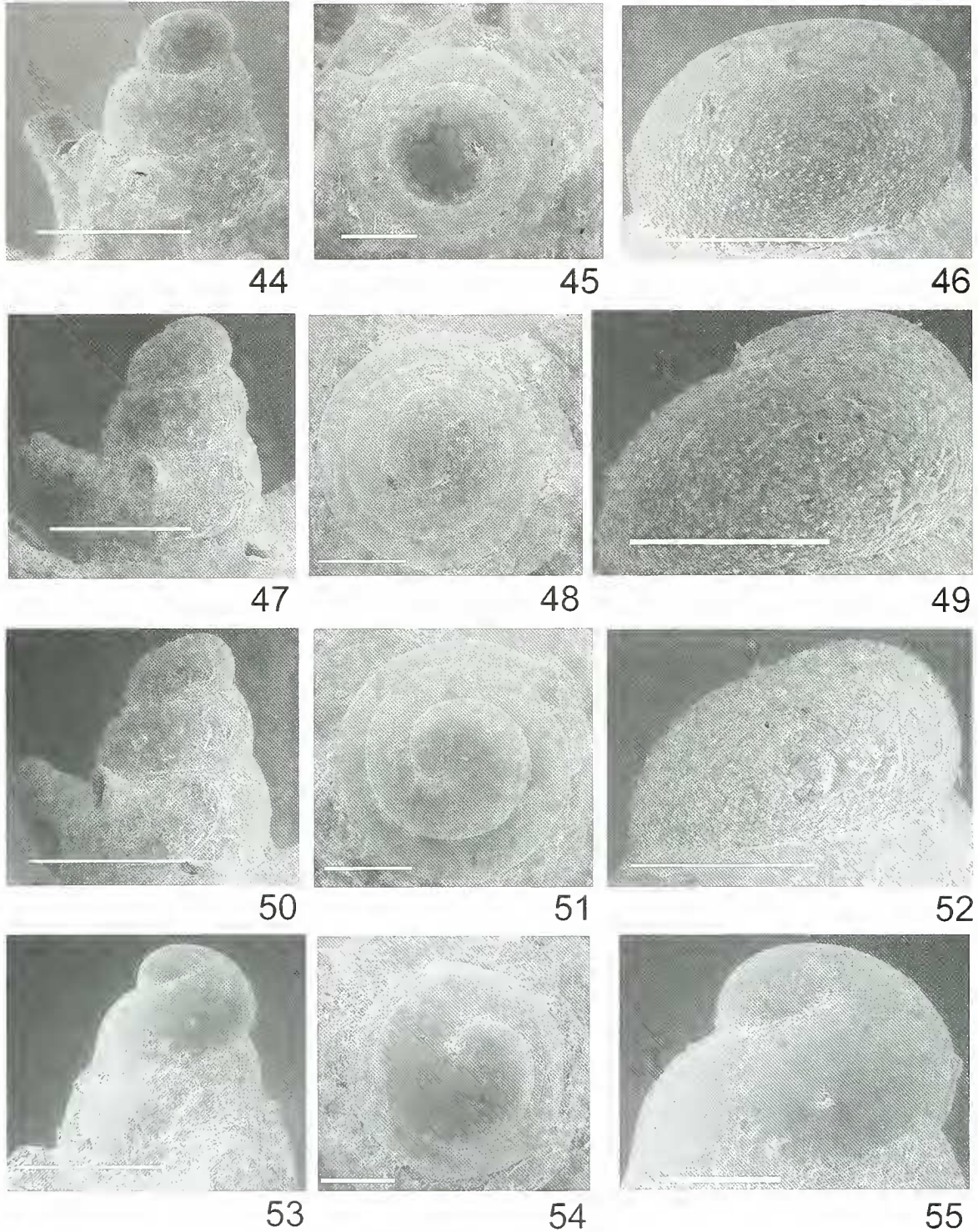
Aperture small, ovate, forming a continuous peristome, erect at outer lip and anterior portion of columellar lip. Siphonal canal long, broad, ventrally sealed, tapering to a slender, dorsally curved tube at distal end. Sutural line weakly shifted to right, left side of canal weakly overlapping right side. Color of protoconch off-white with white pustules on first whorl; teleoconch brown, cream or yellowish-white (sometimes with all three colors on one shell), having darker brown anal tubes, shoulder area, shoulder spines, and tip of siphonal canal. Apertural flange often white even on brown shells. On fresh specimens, not over-cleaned, intritacalx sculpture of simple axial striae present. Operculum corneous, light brown with 12 or 13 concentric lamellae and terminal nucleus. Radula (Figure 68) with rachidian tooth bearing a long central cusp, and on each side 2 shorter, narrower, lateral denticles of approximately same strength and length, and a broad lateral cusp, slightly shorter than central cusp. Lateral teeth sickle-shaped, broad.

Type Material: Holotype: Panama, Isla Venado, Bahía Panama, Panama CASIZ 064667 (formerly SUPTC 9724); 1 paratype CASIZ (formerly SUPTC 9725); 1 paratype BM(NH) 1964433.

Other Material Examined: Mexico: Pta. San Felipe, Baja California, intertidally, in mud and rocks, 28 spec. (CJH); intertidal, in mud between rocks, 7 spec. (CS); intertidal, –1.5 m tide, 19 spec. (SDNHM 81088); 2 spec., intertidal, –1.5 m tide (SDNHM 53452, figured in Radwin and D'Attilio, 1976); intertidal, 9 spec. (SDNHM 82868); 31 spec., intertidal (SBMNH); Bahía la Cholla, Sonora, intertidal in sand over rocks, 7 spec. (CS); intertidal, –1.5 m tide, 2 spec. (SDNHM 90835);



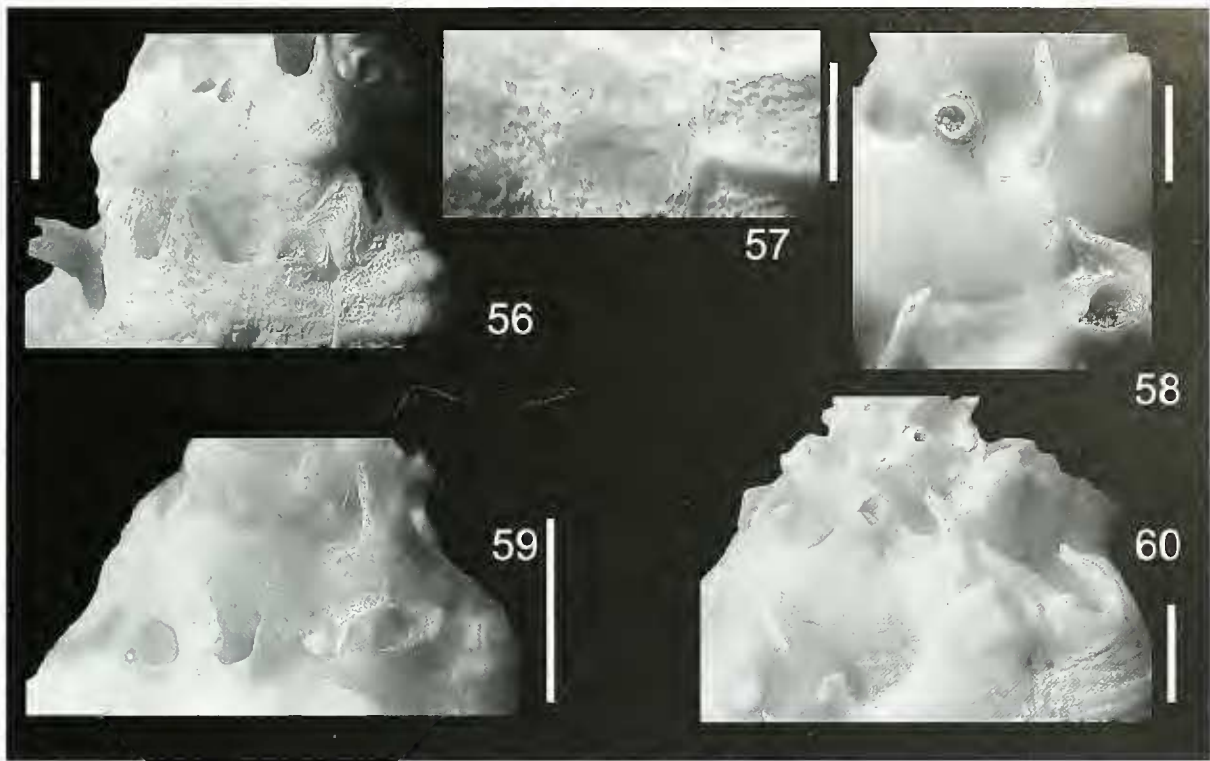
Figures 30–43. Species of *Typhisala*. **30–34.** *Typhisala clarki* (Keen and Campbell, 1964) **30–32.** Panama, off Isla Cébaco, dredged in 6–9 m, silty sand and rubble, RH, 22.8 mm. **33.** Bahía Panama, Isla Venado, under stones at low tide, RH, 22.3 mm. **34.** Mexico, San Felipe, Baja California, (CS), 25.0 mm (photo P. Sadeghian). **35–43.** *Typhisala grandis* (A. Adams, 1855). **35–36.** California, **lectotype** BM(NH) 1974470 (here selected), 37.9 mm (photo P. Crab, BMNH). **37–39.** Mexico, Sonora, San Carlos, Punta Doble, 20–22 m, in rubble, RH, 33.7 mm. **40** *T. grandis*, SBMNH. Mexico, Sonora, Guaymas, Bahía San Carlos, 15 m, 18.0 mm (photo P. Sadeghian). **41–43.** Costa Rica, Province of Puntarena, Isla Ballena, Canton de Osa, offshore, between 12–25 m, RH, 24.0 mm.



Figures 44–55. Protoconchs. 44–46, *Typhisopsis coronatus* (Broderip, 1833). 47–49, *Typhisopsis carolskoglundae* new species. 50–52, *Typhisala clarki* (Keen and Campbell, 1964). 53–55, *Typhisala grandis* (A. Adams, 1855). Scale bars: figures 44, 47, 50, 53 = 0.5 mm; other figures = 200 μ m. All photos by D. Geiger.

3 spec. (SBMNH); Panama: off Isla Cébaco, dredged in 6–9 m, silty sand and rubble, 1 spec. (RH); Isla Venado, under stones at low tide, 1 spec. (RH); 21 spec. (SBMNH); in muddy sand at low tide, 1 spec. (IRSNB

IG 26.817); intertidal, 9 spec. (CS); Isla Gobernadora, intertidal, 1 spec. (SDNHM 93342); Bahía de Panama intertidal (SDNHM 62897); Isla Pedro Gonzales, Islas Perlas, 2 spec. (SBMNH).



Figures 56–60. Detail of spines and intritacalx. **56–57.** *Typhisopsis coronatus* (Broderip, 1833). **58.** *Typhisala clarki* (Keen and Campbell, 1964). **59.** *Typhisopsis carolskoglundae* new species **60.** *Typhisala grandis* (A. Adams, 1855). All R11. Scale bars = 2 mm.

Distribution: San Felipe, Baja California and Bahía la Cholla, Sonora, Mexico to Panama, intertidally to 6 m.

Remarks: The elegant lamellae of the varices, the smooth or nearly smooth shell surface, and the lack of brown spots on the apertural lip and previous varices of *T. clarki* distinguish it from the other three species

Typhisala grandis (A. Adams, 1855)
 Figures 35–43, 53–55, 60, 65–66, 69)

Murex siphoniferus Lesson, 1844: 168 (paralectotype MNHN)
 (see under *Typhisopsis coronatus*).

Typhis grandis A. Adams, 1855: 42, pl. 27, fig. 4.

Typhis (*Typhisopsis*) *grandis*.—Keen, 1944: 54, fig. 18; Abbott, 1974: 192 (201S).

Typhisala grandis.—D’Attilio, 1975: 57, 1 text fig.; Radwin and D’Attilio, 1976: 211, pl. 29, fig. 1; Abbott and Dance, 1982: 155, 1 text fig.

Typhis (*Typhisopsis*) *coronatus*.—Keen, 1971: fig. 1051 (left) (not *T. coronatus* Broderip, 1833).

Not *Typhis* (*Typhisopsis*) *grandis*.—Keen, 1971: 540, fig. 1052 (= *Typhisopsis coronatus*).

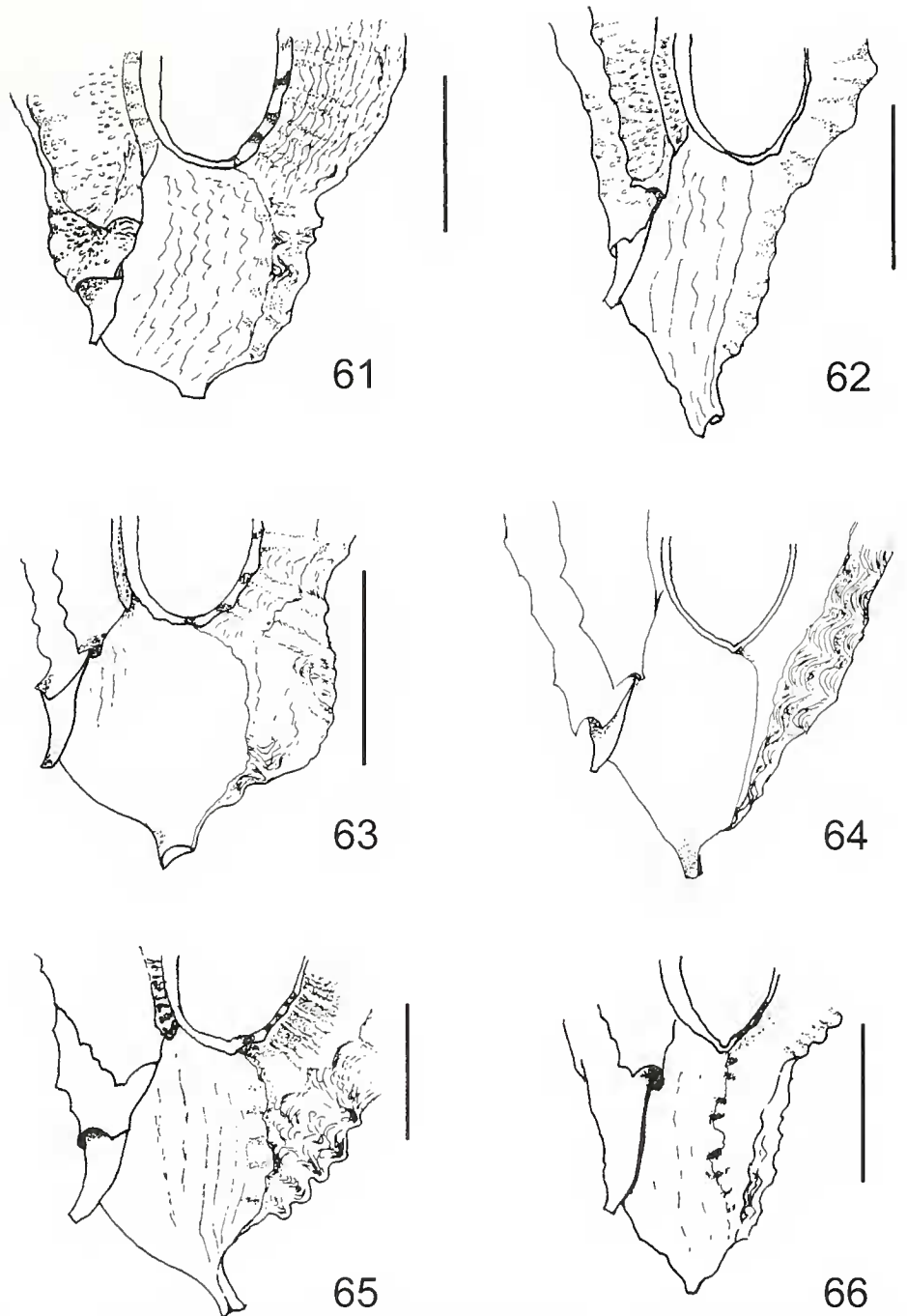
Not *Typhisala grandis*.—D’Attilio, 1957: figs. 1–6; D’Attilio and Hertz, 1955: fig. 10S, a–e (= *Typhisopsis carolskoglundae* new species).

Description: Shell up to 37.9 mm in length, broad, heavy. Spire low or moderately high, angulate; protoconch off-white of 2.5 rounded, smooth whorls, first whorl not pustulose (Figures 53–55); teleoconch of up to six strongly shouldered whorls, broadly rounded on last

two whorls. Suture deeply impressed, obscured by succeeding whorls. Axial sculpture from first teleoconch whorl to antepenultimate whorl consisting of four low, sharp, varices, becoming broadly rounded at periphery of penultimate and last whorl with a sharp flange extending out from the varix becoming fimbriate on its leading edge; each varix with a moderately slender, curving spine at its adapical extremity. Immediately adjacent to the spine is a deep indentation anteriorly, next to which the anal siphon (tube) rests against the former partition. Final anal siphon (functioning tube) long, at approximately 90° to the shell axis. Apertural varix broadly expanded, constricted at anterior end; outer edge, reflected and densely fimbriate; connected to previous teleoconch whorl by a broad, high, densely lamellose partition. Apertural spine short, sharply dorsally curved.

Spiral sculpture of sharp, raised primary cords, secondary cords visible under magnification (10×). Last whorl, including siphonal canal with 22–23 cords. P1 with sealed, rounded anal tube, P2 ornamented with short spine at intersection with varix. Other cords cannot be quantified. Spiral cords of approximately same magnitude, more obvious on varices, ending as short, strongly backwards curved, short spine at outer edge of apertural varix.

Aperture round-ovate, forming a continuous erect peristome; outer lip with 3–5 brown spots often appearing as well on leading edge of varices, brown spot also appearing on each intervarical area; Siphonal canal long,



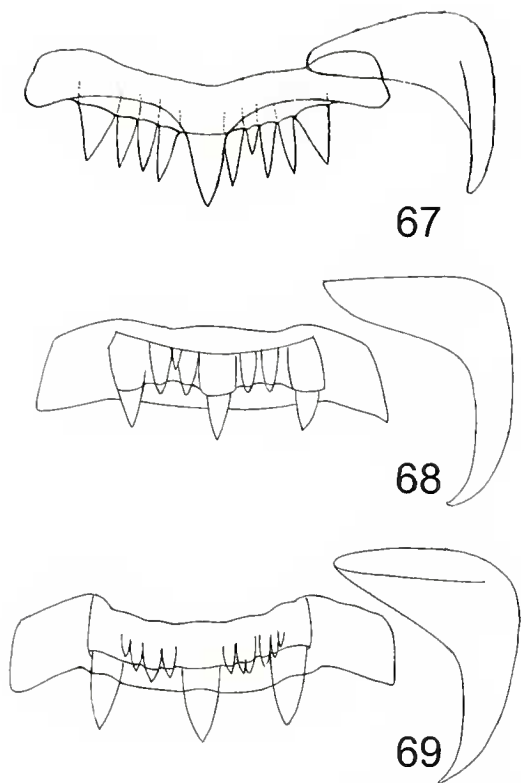
Figures 61–66. Siphonal canal. **61–62.** *Typhisopsis coronatus* (Broderip, 1833). **61.** Adult specimen. **62.** Juvenile. **63.** *Typhisopsis carolskoglundae* new species **64.** *Typhisala clarki* (Keen and Campbell, 1964). **65–66.** *Typhisala grandis* (A. Adams, 1855). **65.** Adult specimen. **66.** Juvenile. All RH Scale bars = 0.5 mm.

broad (Table 1) ventrally sealed. Sutural line strongly shifted to the right, left side of canal broadly overlapping right side. Microsculpture of thin, low, curved, lamellae covering the canal and weakly overlapping varices, except apertural varix. Intritacalx off-white, sometimes thick, with occasional axial striae.

Color milky-white to lavender, light tan, tan or almost entirely dark brown with brown colored spines, anal

tubes, and shoulder area. Other brown spots between spiral cords, on outer lip of aperture, on leading edge of varices, not intervarically and occasionally on sutural line of siphonal canal. Operculum corneus, light brown, with 11–12 concentric lamellae and terminal nucleus.

Radula (Figure 69) with rachidian tooth bearing a long central cusp, and on each side 3–4 short, narrow, lateral denticles of varied strength and length, occasionally fused



Figures 67–69. Radulae (from D’Attilio and Hertz, 1988). **67.** *Typhisopsis coronatus* (Broderip, 1833), Islas Galápagos, Isla Jervis. **68.** *Typhisala clarki* (Keen and Campbell, 1964), Mexico, Baja California, San Felipe. **69.** *Typhisala grandis* (A. Adams, 1855), Mexico, Bahía de Banderas. Unknown magnifications.

or split, and a long, broad lateral cusp slightly shorter than central cusp. Lateral teeth sickle-shaped, broad.

Type Material: BM(NH) 197470, 3 syntypes here selected as lectotype and paralectotypes (Figures 35–36), “California” (see Remarks).

Other Material Examined: Mexico: Punta Doble, San Carlos, Sonora, 20–22 m, in rubble, 1 spec. (RH); 2 dd spec. 20–21 m diving, (SDNHM 90534); 18–21 m, 4 spec. (CS); divers, 20–21 m in rubble, 2 dd spec. (SDNHM); off Bahía San Carlos, Sonora, dredged 31–75 m, 12 spec. (CS), 3 spec. (CJH); dredged 60 m, 2 spec. (CJH); dredged 3–5 m, 4 spec. (SDNHM 76475); 64 spec. (SBMNH); 3 mi SE San Antonio, Guaymas, Sonora, dredged 100 m, 2 dd spec. (SDNHM 80764); Manzanillo, Colima, 20 spec. (SBMNH); in 6 m, (SDNHM 23215 [as *quadratus*]); Costa Rica: Isla Ballena, Puntarenas, offshore, 12–25 m, 4 spec. (RH); 4 spec., (RZ); Isla Ballena, Canton de Osa, Puntarenas, offshore, between 12 and 25 m, 10 spec. (subadult, dd) (RH); 3 spec. (CJH); 2 spec. (RZ); Panama: 10 spec. (SBMNH); Isla Gobernadora 1 spec. (MNHN); extreme low tide, in muddy sand near rocks, 1 spec. (RH); low tide, in muddy sand, 1 spec. (RH); Isla Cébaco, dredged in 37 m, sand

and gravel bottom, 1 spec. (RH); 62–93 m, 1 spec. (IRSNB IG 26.817); 37–52 m, 1 spec. (IRSNB IG 27.037); Isla Santa Catalina, dredged 5–8 m, 1 spec. (RH); Isla Venado, intertidal, 1 spec. (CS). Ecuador: Islas Galápagos, Isla San Salvador, close to Bahía James, 30–35 m, coll. D.R. Shasky, 1 spec. (SBMNH 366003).

Distribution: Punta Doble, Sonora, Mexico to Panama and the Islas Galápagos, Ecuador, intertidally to 62 m.

Remarks: Of the three syntypes of *Typhis grandis* housed in BM(NH), two are *Typhisopsis coronatus*, the other is *Typhisala grandis*. In order to maintain the status of *T. grandis* as it was illustrated by recent authors (except Keen, 1971), one syntype specimen is here designated as the lectotype (Figures 35–36). The type locality is doubtful because, to our knowledge, no specimen has ever been reported from California since then. Many times in old publications “California” is also used for “lower California” now known as Baja California which is part of Mexico. It is probably the case here. Subadult forms of *T. grandis* (Figures 40–43, 66) differ from the adult form, in having a narrower, lower partition, a rounded apertural varix without varical flange, a narrower, more acute, siphonal canal, with the ventral sutural line being more central. In adults the left side of the canal extensively overlaps the right side (Figure 65).

Discussion: Both *Typhisopsis* and *Typhisala* seem to be closely related, and it seems questionable whether both are separate or not. However, several differences have been detected so far: In *Typhisopsis* the varical spine is flat, broadly triangular and strongly inward bent (Figures 56, 59), compared to the longer, weakly twisted spine in *Typhisala* (Figures 57, 60) and the apertural varix of *Typhisala* is fimbriate and broadly expanded whereas the apertural varix of *Typhisopsis* is narrower and more rounded with heavy raised spiral cords. The question is whether or not such differences are significant enough to warrant separate genera. Maybe DNA work would be useful in this particular case.

ACKNOWLEDGMENTS

We are most grateful to M. G. (Jerry) Harasewych and Paul Greenhall (USNM) for the loan of *Typhis martyria* Dall, 1902; to Kathie Way and Phil Crabb (BMNH) for digital images; to Virginie Héros and Delphine Brabant (MNHN) for help in searching literature and specimens from the collection of MNHN and for digital images; to Paisley Cato and Laura Halverson (SDNHM) for loan of the two type specimens of *Typhisopsis carolskoglundae*; to George Metz, Novato, California, for digital images of the holotype of *Typhis clarki* at CAS; to Kelvin Barwick (City of San Diego EMTS Lab) for digital images of the holotype and paratype of *Typhisopsis carolskoglundae*; to Daniel Geiger (SBMNH) for SEM photographs of the protoconchs of the four species; to Patricia Sadeghian (SBMNH) for digital images of the complete speci-

Table 2. Characters of Eastern Pacific Species of *Typhisopsis* and *Typhisala*.

Character	Character states			
	<i>Typhisopsis corouatus</i>	<i>Typhisopsis carolskoglundae</i>	<i>Typhisala grandis</i>	<i>Typhisala clarki</i>
1. Protoconch	2.75 white, conical, rounded whorls, pustulose on first whorl	2.66 rounded whorls, pustulose on first whorl	2.5 cream-colored, rounded whorls, none pustulose	2.75 white, smooth, conical rounded whorls, pustulose on first whorl
Last teleoconch whorl ^o	Moderately broad	Broad	Broad	Broad
1. Shoulder spine	Flat, broad, not twisted at base, sharp, incurved at acute end	Flat, not twisted, long, broad at base, curved at acute end	Weakly twisted, long, broad at base, bent dorsally	Weakly twisted, broad base, long, open at distal end
2. Anal tube position	Tubes adjacent to leading edge of preceding varix and appressed to previous partition.	Tubes adjacent to leading edge of varix and appressed to previous partition	Tubes adjacent to preceding varix, appressed to preceding partition	Tubes approximately midway between varices, appressed to preceding partition
3. Number of spiral cords (siphonal canal included)	10–11, broad	13–15, narrow, broadly spaced	21–22, narrow, broadly spaced on siphonal canal	12–14, only visible on sharp edge of axial ridges, otherwise smooth
4. Axial ribs	Broad, rope-like rounded varices, apertural varix with varical flange	First three teleoconch whorls with sharp varices; remaining whorls broad, rounded; apertural varix with broad varical flange, roundedly curving into siphonal canal approximately 0.25 before distal end	Broad, rounded; abapical portion with small, thin, erect lamellae; apertural varix with broad varical flange	Angular, sharp, formed by two appressed lamellae; apertural varix expanded.
5. Apertural varical flange	Edge reflected; weakly squamose, spiral cords obvious, more strongly squamose on outer portion	Broad, recurved; fimbriate on its outer portion, roundedly curving into spherical canal	Broadly expanded, recurved; strongly fimbriate on its outer portion, strongly constricted at anterior end	Broad, reflected as shallow open spinelets; strongly fimbriate on its outer portion
Siphonal canal ^o	Moderately broad, long, tapering	Moderately broad	Broad	Tapering, long
1. Mean: breadth/length	6.08/7.76 mm	8.05/7.85 mm	9.41/9.57 mm	4.91/7.62 mm
2. Position of the sutural line	Broadly overlapping the right side	Broadly overlapping right side	Broadly overlapping the right side	Strongly overlapping the right side
Intritalcax	Distinctive, chalky, off-white, deeply irregularly pitted	Chalky, off-white, simple with occasional axial striae	Chalky, often thick, off-white, simple, with occasional axial striae	Chalky, thin, off-white to cream, simple with occasional axial striae.

^o Characters of adult shells only

mens with protoconchs; to Jacky Van Goethem, Claudine Claes and Diana Hoortman (IRSNB) for help in searching literature and access to the collection of IRSNB; to Ricky Zandali, Marsh Harbour, Abaco, Bahamas, for the loan and gift of specimens, and to Carol Skoglund for donating type material of the new species to the USNM and LACM as well as lending comparative material of the four species for study.

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